For comparison with the last diagrams reference might be made to a paper by Mr. Burnham in the June number of *Astronomy and Astro-physics*, 1894, on the "Variable Proper Motion of *Procyon*," in which he discussed a series of measures of differences in declination between *Procyon* and two adjacent stars made during the years 1851–1890, by Otto Struve, and published in vol. x. of the Pulkova observations.

It does not seem probable that any further discussion of this series of observations, either of *Sirius* or *Procyon*, would lead to any results appreciably different from those deduced by Professor Auwers.

Note on the Measurement of Paper Prints of Stellar Photographs.

By Professor H. H. Turner, M.A., B.Sc.

1. The question of the accuracy attainable in measurements of a paper print is important, because the publication of a photograph in this form is a comparatively simple matter. The following brief notes of some experiments recently made at the University Observatory, Oxford, will, perhaps, serve to draw attention to the matter, though they are far from being a complete settlement of the question.

2. It is of course all-important that the original negative should have the *réseau* impressed upon it. If there is no *réseau* on the original negative, a glass copy can be made on which the *réseau* lines have been previously impressed, just as in preparing a plate for the telescope; and the paper prints can then be made from this copy. As a digression I would remark that there are some advantages in *not* having the *réseau* on the original negative. It can be put on the positive copy in the laboratory much more conveniently *and correctly* than on the original negative; that is to say, after examining the negative, and measuring one or two known stars, the *réseau* can be adjusted so that its lines are very nearly in the true directions for epoch 1900·0, and the centre at the proper point on the plate. Further, no stars less than the tenth mag. are obliterated on the original plate. Of course its lines would no longer be parallel to the fiducial edge of the plate. I am supposing this edge to be not used as fiducial.

3. The paper print having then a *réseau* on it, we proceed to measure the position of a star in any square of the *réseau*, for comparison with similar measures on the original negative. The print may be held between two pieces of plate glass, or wetted and squeezed to one of them. It must be viewed by reflected light, not transmitted light, as in the case of the original negative.

4. The following measures in the x coordinate were made of twelve stars on plate 703, and a platinotype print of it.

Plate 703, R.A., 10h 48m. zone + 28°, exposed 1895 March 7.

Column 1 gives a number for reference.

Column 2 gives the approximate y coordinate expressed in *réseau* intervals from one corner.

Column 3 gives the diameter of the star-disc on the negative. The letter *e* denotes that the disc is much elongated, and a mean diameter is given.

Column 4, the x coordinate as measured on the original negative by the glass-scale micrometer described in *Monthly Notices*, lv. p. 102.

Column 5, the x coordinate as measured on the print with the screw micrometer, and the mean of several bisections (the object here being to determine systematic *not* accidental errors). The correction for "runs" was made on the assumption that the deformation was uniform over the square under examination.

Column 6 gives the differences, only one of which is as large as ·003 or 0.″9.

TABLE I.

(The results are all expressed in *réseau* intervals.)

Star.	y. (Approx.)	Diam.	Coordinate x. Negative.	Print.	P—N.
1	0·3	0·030	8·695	8·696	+ ·001
2	0·6	·030	9·621	9·621	0
3	0·6	·030	12·082	12·081	— 1
4	1·2	·038*e*	4·541	4·538	— 3
5	1·5	·012	9·083	9·082	— 1
6	1·8	·010	9·060	9·061	+ 1
7	1·7	·020	20·896	20·897	+ 1
8	1·2	·028	22·533	22·533	0
9	4·2	·023	22·836	22·835	— 1
10	21·2	·017	22·318	22·319	+ 1
11	23·1	·018*e*	21·741	21·740	— 1
12	20·8	·020	4·632	4·634	+ 2

Measurer of negative, Miss Turner; measurer of print, Mr. Bellamy.

These measures are all near the edge of the plate, where it was expected to find the deformation greatest.

5. The following measures on the same print were made by Professor Turner nearer the middle of the plate, with the glass-scale micrometer in general use for measuring plates. The

measures of the negative in columns (2) and (6) are, as before, those recorded by Miss Turner or Mr. Bennett in the ordinary course of measuring this plate last March. The measures in columns (3) and (7) were repeated specially by Mr. Bellamy. The mean of the two is taken for comparison with those on the print in columns (5) and (9).

TABLE II.

(Results expressed in *réseau* intervals as before.)

Diam. (Negative.)	*x* Coordinate. Negative.		Print.	P—N.	*y* Coordinate. Negative.		Print.	P—N.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
8*	4·418	·419	...	...	13·265	·265	...	...
22	5·635	·633	·635	+·001	·387	·387	·390	+·003
10	9·120	·119	·118	−·002	·440	·442	·437	−·004
11	9·702	·703	·698	−·005	·360	·362	·366	+·005
10	9·822	·822	·828	+·006	·595	·596	·592	−·004
13	9·940	·938	·941	+·002	·425	·425	·427	+·002
8*	10·454	·456	...	...	·507	·507	...	...
20	14·603	·603	·602	−·001	·378	·377	·380	+·002
9	19·589	·589	·589	·000	13·889	·888	·889	·000
10	3·554	·553	·556	+·002	14·178	·176	·177	·000
11	7·598	·596	·596	−·001	·165	·163	·164	·000
12	10·375	·374	·371	−·004	·314	·312	·312	−·001
14	21·376	·376	·373	−·003	14·540	·538	·540	+·001

The mean residual is $\pm$·002 or $\pm$ 0″·6. The measures on the print are not so good as those given in Table I. They are single measures with the glass-scale micrometer, instead of means of several careful bisections with a micrometer screw. And some difficulty was found in estimating the place of the broad and diffused images. The *réseau* lines on the plate are in fact not so good as they might be. The plate is, if anything, rather below the average in many respects, and the errors ought not generally to be so large as these.

6. Eleven stars on a pair of platinotype prints were measured with the glass-scale micrometer; the results are given in Table III.

* These two stars were not seen on the print.

TABLE III.

Plate 702. R.A. $10^h\ 30^m$. Zone $+28°$. Exposed 1895 March 7.

Two Platinotypes (positives) mounted on plate glass, with the back to the glass.

(1) Star.	(2)	(3)	(4)	(5)	(6)	(7)
	x Coordinate.			*y Coordinate*		
	A.	A. (repeated.)	B.	A.	A. (repeated.)	B.
1	11·079	11·085	11·083	2·596	2·587	2·592
2	11·591	11·591	11·595	3·271	3·270	3·281
3	11·723	11·724	11·726	7·210	7·210	7·217
4	11·952	11·951	11·950	9·763	9·762	9·764
5	11·925	11·925	11·925	18·444	18·344	18·339
6	12·378	12·373	12·372	9·874	9·870	9·874
7	12·556	12·556	12·551	11·616	11·618	11·616
8	12·214	12·214	12·215	15·775	15·774	15·776
9	12·589	12·592	12·595	18·627	18·627	18·624
10	12·767	12·771	12·774	20·182	20·182	20·181
11	12·138	12·139	12·140	20·268	20·270	20·267

These measures by Mr. Bellamy.

The measures given in columns (2) and (5) were made on November 6; the light was very bad.

Those in columns (3) and (6) were made on November 7, and are remeasurements of print A.

And those given in columns (4) and (7) were made on November 7, and from a different print, marked B.

The difference in y for star 2 is real; Mr. Bellamy went over the measures several times, and also examined all the other large differences.

The *réseau* lines are diffused on both these prints, owing to the lines on the negative being blurred. Another form of micrometer would, therefore, perhaps give better results, especially one where the setting on the *réseau* lines is made by a pair of wires, including a considerable portion of the line.

7. It seems to me, however, that these differences are, on the whole, very small. Briefly we can depend on paper prints (not enlargements, simply contact prints) to give us the places of

stars within 1″, possibly more accurately, and this is a fact well worth considering. I do not know how far the accuracy of paper prints treated in this way is known. It may be well to recall here some remarks made early in the history of the Chart by Dr. Gill, which perhaps may be taken to represent ideas on the subject generally. Dr. Gill gives no figures, and the only gauge of the accuracy he expects is afforded by the suggestion of a "rule and compass" method; it would appear to me that this does not give a sufficiently high estimate in the light of the above facts.

8. In the Procès-Verbaux of the meeting of the Comité Permanent in 1889 September, Annexe No. 1, are printed the notes presented to the Comité by Dr. Gill, and on p. 85, under the head Publication de la Carte, we read as follows :—

"Des copies de la carte sur verre entraîneraient des dépenses considérables; en outre, ce mode de publication est peu commode si l'on veut mesurer les plaques à l'aide d'une lunette, les images stellaires sur le négatif original étant trop petites pour être aperçues à l'œil nu. Le mode le plus simple consisterait, je le crois, à reproduire les plaques originales sur du papier, à l'aide de la photogravure ou de tout autre procédé analogue, en les agrandissant de trois diamètres, afin de rendre visibles les étoiles les plus faibles. . . . A l'aide du compas et de la règle on pourra déterminer sur ces copies à l'échelle de $3^{mm} = 1'$ la position d'une étoile quelconque du cliché, sinon avec une extrême, du moins avec une grande précision. Ce mode de publication ne serait pas très coûteux, la dimension des plaques serait peu gênante; de plus, on pourrait éliminer toute déformation du papier en ayant égard aux lignes du *réseau*."

9. The deformation of the paper has of course been allowed for in the above measures by the method of "runs," assuming it uniform throughout a square. It is a sensible quantity, and (as might be expected) different in the two coordinates. The stretching in the case of the above platinotype print was about ·003 in one direction and about ·013 in the other—a difference of 1 per cent. To test the regularity of the stretching across the paper, the widths of the spaces between consecutive *réseau* lines were measured across the plate, as below (Table IV.) with the screw micrometer. The results are expressed in *réseau* intervals as usual. The screw is not quite uniform, but the same part of it was used in measuring negative and print, so that the irregularity is eliminated from the differences N − P. The measures were made by Mr. Bellamy.

TABLE IV.

(1) Space.	(2) Interval on Negative.	(3) Interval on Print (1).	(4) Interval on Print (2).	(5) N−P₁.	(6) N−P₂.
0–1	0·9990	0·9961	...	+·0029	...
1–2	1·0007	0·9947	...	+·0060	...
2–3	0·9993	0·9974	...	+·0019	...
3–4	1·0004	0·9973	...	+·0031	...
4–5	1·0015	0·9984	...	+·0031	...
5–6	0·9981	0·9938	...	+·0043	...
6–7	1·0010	0·9986	...	+·0024	..
7–8	1·0012	0·9968	...	+·0044	...
8–9	0·9995	0·9953	...	+·0042	...
9–10	1·0010	0·9981	0·9960	+·0029	+·0040
10–11	0·9999	0·9966	0·9991	+·0033	+·0008
11–12	1·0000	0·9930	0·9902	+·0070	+·0098
12–13	1·0003	0·9989	0·9989	+·0014	+·0014
13–14	1·0015	0·9998	0·9981	+·0017	+·0034
14–15	1·0000	0·9936	0·9950	+·0064	+·0050
15–16	1·0003	0·9966	0·9977	+·0037	+·0026
16–17	1·0007	1·0020	1·0016	−·0013	−·0009
17–18	1·0007	0·9956	0·9970	+·0051	+·0037
18–19	1·0016	0·9970	...	+·0046	...
19–20	1·0005	0·9984	...	+·0021	...
20–21	0·9988	0·9943	...	+·0045	...
21–22	1·0006	0·9992	...	+·0014	...
22–23	1·0018	0·9977	...	+·0041	...
23–24	1·0008	0·9951	...	+·0057	...
24–25	1·0006	0·9930	...	+·0076	...
25–26	1·0023	0·9984	...	+·0039	...

The differences shown in column (5) are fairly regular with a few exceptions. To test the reality of the exceptions, the portion 9–18 was remeasured, as shown in columns (4) and (6). The differences in column (6) agree sufficiently well with those in column (5) to show that the abnormality of space 16–17, for instance, is real; but at the same time there are undoubtedly sensible accidental errors. Cp. the measures of space 10–11.

The existence of three consecutive spaces like 15–16, 16–17, and 17–18, whose widths are in the proportion 0·997, 1·001, 0·996, shows that the assumption of uniformity in the "runs" throughout one interval will not always give us accurate results, for we have no information as to where the change takes place.

10. The present note is not concerned with several matters of great importance; as, for instance, the possibility of securing all the stars on the print which are on the original plate. In the print above measured faint stars have certainly been lost. For the present I am only concerned with the value of such prints, in default of the original plate, for getting star-places with considerable accuracy. The experiments will be continued, and a fuller account of them given later. But if the question of the publication of the Chart is to be dealt with at the next meeting of the Permanent Committee, it is not too early to draw attention to the possibilities contained in paper prints, which have so many advantages over glass copies in the way of convenience.

Photograph of the Nebula H VI. 41 *and a new Nebula in Draco.*

By Isaac Roberts, D.Sc., F.R.S.

The photograph of the spiral nebula H VI. 41 *Draconis*, R.A. $17^h\ 33^m$, Decl. 75° 48′ north, and of the new elliptic nebula, R.A. $17^h\ 26^m\ 21^s$, Decl. 75° 8′·6 north (epoch 1860), was taken with the 20-inch reflector on 1895 September 11, with an exposure of the plate during 60 minutes, and the copy now presented is enlarged to the scale of 1 millimetre to 15 seconds of arc.

The nebula H VI. 41 is N.G.C. No. 6412, G.C. No. 4321, and is described by Sir J. Herschel as a globular cluster, considerably large, round, very gradually brighter in the middle, partially resolved.

The photograph shows it to be a spiral nebula, with a bright stellar nucleus, which appears to be elongated in *north following* and *south preceding* directions; and, involved in the spirals, are three or four nebulous star-like condensations. The general appearance of the nebula, and of the surrounding region of the sky, will best be appreciated on the photo-copy of the negative, now projected on the screen.

The elliptic nebula (supposed to be here recorded for the first time) is elongated in nearly *north* and *south* directions, with dense nebulous condensations in the interior and well-defined margins on the *preceding* and *following* sides, but the north and south ends are undefined, and shade gradually into invisibility. The length of the nebula does not exceed 70 seconds of arc, and the 9·2 magnitude star, D.M. No. 629, zone 75°, is about 30 seconds of arc *south preceding* it.

It will be observed on the photograph that the region of the sky surrounding these nebulæ is rather sparingly covered with stars, and that they are all fainter than 8th magnitude.
